DOCUMENT RESUME

ED 305 232 SE 050 410

AUTHOR	Barber, Brenda, Comp.; Michell, Mick, Comp.
TITLE	Better Science: Building Primary-Secondary Links. Curriculum Guide 10.
INSTITUTION	School Curriculum Development Committee, London (England).; Secondary Science Curriculum Review, London (England).
SPONS AGENCY	Association for Science Education, Cambridge (England).
REPORT NO	ISBN-0-435-54821-2
PUB DATE	87
NOTE	33p.; For the curriculum review see SE 050 400; for other curriculum guides in this series see SE 050 401-412.
AVAILABLE FROM	Heinemann Educational Books, Inc., Halley Court, Jordan Hill, Oxford OX2 8EJ, United Kingdom ($44.40 English pounds per set).
PUB TYPE	Reports - Descriptive (141) -- Viewpoints (120) -- Guides - Non-Classroom Use (055)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Curriculum Development; *Educational Improvement; *Elementary School Science; Elementary Secondary Education; Foreign Countries; *Instructional Development; Instructional Improvement; *Science Curriculum; Science Departments; Science Education; Science Instruction; Science Teachers; Secondary School Science
IDENTIFIERS	*United Kingdom

ABSTRACT

This publication is one in a series of 12 giving the recommendations that were made for a broad and balanced education program in science for young people. This guide attempts to answer the questions regarding what science is taught in primary schools, what skills good primary science gives children, and how secondary schools build on primary science. The guide was written basically for secondary teachers but is of interest to all who care for science in primary schools. Following an introduction, section one identifies some of the problems such as safety education and primary teachers training in science. Section two discusses organization and science in the classroom and section three looks at primary science policy at the two levels of the school. Section four addresses liaison for children, teachers, departments, and schools, possible outcomes, what other people have done, and a conclusion. An appendix summarizes the findings of a teachers' group in Croydon, England (the Primary-Secondary Interface). Further readings and references are presented. (RT)

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

Building primary-secondary links

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Curriculum Guides

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

Building primary-secondary links

Curriculum Guide 10

Compiled by Brenda Barber and Mick Michell

Heinemann Educational Books/Association for Science Education
for the School Curriculum Development Committee

The Secondary Science Curriculum Review has run from 1981–1986 (Phases 1 and 2), with a dissemination phase (Phase 3) from 1986–1989.

The Review operates under the aegis of the School Curriculum Development Committee and is supported by the Association for Science Education. In addition, it receives or has received support from the Department of Education and Science, local education authorities, the Schools Council (Phase 1), the Northern Ireland Council for Educational Development (Phase 2), the Health Education Council (Phase 2), industry (particularly British Petroleum), the Department of Trade and Industry, and the Independent Broadcasting Authority.

Heinemann Educational Books Ltd
22 Bedford Square, London WC1B 3HH

LONDON EDINBURGH MELBOURNE AUCKLAND
SINGAPORE KUALA LUMPUR NEW DELHI IBADAN
NAIROBI JOHANNESBURG PORTSMOUTH (NH) KINGSTON

The Association for Science Education,
College Lane, Hatfield, Herts

ISBN 0 435 54821 2
© SCDC Publications 1987
First published 1987

Typeset by Artext Ltd, London
Printed and bound in Great Britain by
Scotprint Ltd, Musselburgh

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Acknowledgements

The ideas presented in this Guide are not only the result of the work of SSCR groups. Their production has also relied on considerable discussion in, and on the collective wisdom of, the SSCR Central Team:

Beverley Bell (CLIS Project Coordinator 1984–85), Di Bentley (Research and Development Officer, Health and Science Education 1983–86), Paula Bower (Information Officer 1984–86), Christine Ditchfield (Southern Regional Project Officer), Dave Ebbutt (Evaluation Officer 1983–86), Kate Ellington (North West Regional Project Leader 1983–86), John Heaney (Midlands Regional Project Officer), Joseph Hornsby (North Regional Project Officer), Ruth Jarman (Northern Ireland Regional Project Leader 1983–84), Jeff Kirkham (Director from 1986; Director Designate 1985–86), Anna Larter (Project Administrator), Mick Michell (Director 1985-86; Deputy Director 1982–85), Val Oldham (CLIS Project Coordinator 1985–86), Denis Stewart (Regional Project Officer Wales & West Midlands from 1986; Northern Ireland Regional Project Leader 1984–86), Jeff Thompson (Chairman, SSCR Steering Committee), Mike Watts (Anglia Regional Project Leader 1983–86), Dick West (Director 1981–85), Cathy Wilson (ASE/SSCR Liaison Officer).

This Guide draws on the work of two SSCR groups: Croydon Primary–Secondary Interface Group and Leicestershire 10+ Science Group.

The compilers are very grateful to Graham Hill, Ruth Jarman, Jock Killick, Fred Riddell, and John Slade for their perceptive comments and help in the compilation of this particular Guide, and to the Inner London Education Authority and the Roehampton Institute of Higher Education for allowing the participation of Brenda Barber in the work of preparing it.

The Publishers would like to thank the following for permission to use extracts from other publications or some of their own material:

S. Lloyd; Ravenstone Nursery; Henry Cavendish Infants School; Henry Cavendish Junior School; Honeywell Infants School; Cubitt Town Infants School; The Boutcher Church of England Primary School; The Inner London Education Authority for permission to use materials produced by ILEA schools; Norfolk County Council; Humberside County Council and Northumberland County Council for the extracts from their education policy statements in Section 3.

Foreword

This is the tenth in a collection of twelve Curriculum Guides from the Secondary Science Curriculum Review, published jointly by Heinemann Educational Books and the Association for Science Education.

A Directory of Resources and a book, *Better Science: Making it happen*, which tries to set the Review's recommendations in the context of the whole school, will appear at the same time as the Guides. These will, when taken with earlier and forthcoming SSCR publications, including those from local groups, constitute the recommendations which the Review is making towards a broad and balanced science education for all the young people in our schools. The series title 'Better Science' is thus both apposite and self-explanatory. It is hoped that the current phase of the Review (1986–89) will achieve successful implementation of the recommendations.

But what is the status of these new publications apart from reflecting the formal approval and support of our major sponsors, the School Curriculum Development Committee and the Association for Science Education? From what sources have the recommendations within them emanated? Those readers unfamiliar with the history of the SSCR will find it explained within the Guides; but most will be aware that it set out as a project which tried fully to involve the practising teacher in the development of solutions to the problem of science for all. Thus, although the Guides have been compiled principally by the Central Team of the Review, they draw on the work of thousands of teachers in working groups over the past four years. Although the work of many of the groups is referred to in the Guides, it is not possible to refer to it all. In the *Directory of Resources* readers will find details of what many of these groups have produced. The writing of these Guides, however, would not have been possible without the groups' existence and the Review Central Team hopes that the content of the guides truly reflects their work. Thus the pronoun 'we', used within them, often reflects the view, gleaned over five years of consultation, of the practising teachers involved with the Review. On other occasions it can represent the views of the SSCR as constituted by the Central Team and Steering Committee and it is hoped that particular usage will be apparent from the context.

Jeff Kirkham
Mick Michell
Jeff Thompson
Dick West
(SSCR Curriculum Guide Editors)

Introduction: why spend time on liaison?

Emma is now three years old; she will be eighteen in the year 2000. The vast majority of the teachers she will meet during her years of primary education are already in the profession. Emma and her contemporaries will find that many of their secondary teachers will also have been teaching for a long time. What will Emma think of her primary education? At a time when resources are being directed at primary science education, how will her primary science strike her? And finally, how well will her secondary school build upon her previous scientific experience?

This Curriculum Guide has been written mainly for secondary science teachers, though it is hoped that primary teachers, other secondary teachers and those in other educational spheres will also find it of interest. It attempts to

- explore answers to the questions we have posed concerning Emma and her contemporaries;
- convince the reader that time spent on the development of primary–secondary continuity in science education is a proper use of a science resource;
- study the constraints which generally make such continuity difficult to achieve;
- give a few examples of good practice in primary science with the intention of helping the reader to a better realisation of what to build upon;
- discuss primary science policy at both school and LEA levels and look at how it can be translated into classroom practice;
- give secondary teachers some practical suggestions as to how they might embark upon liaison with their local primary schools.

We hope that this Curriculum Guide, rather than being regarded as a source of definitive answers, will be used as a starting point for local discussion about improving primary–secondary continuity. The view of the SSCR is that many of the problems we commonly encounter in secondary science education could be avoided or more easily resolved if secondary schools not only built upon, but also developed further, the practice of the primary sector.

When do children begin to study science?

Sir George Porter was once asked (**0.1**) in a radio interview:

When did you first become interested in science?

His reply was,

When I was about one year old.

Albert Einstein is reputed to have said (**0.1**),

Even a physicist learns half his [sic] *Physics by the age of three.*

A 4½-year-old child was once asked to say what a lift was. She said,

It's a little room and, when you get into it, the upstairs comes downstairs. (**0.1**)

Niko Tinbergen (**0.2**) gives a delightful description of a one-year-old's exploratory behaviour:

. . . a twelve month old boy guarded by his aunt and grandmother was observed crawling about over a sandy slope which was bare but for isolated rosettes of ragwort and occasional thistle plants. After having moved over ragwort rosettes without showing any reaction to them, he happened to crawl over a thistle whose prickly leaves slightly scratched his feet. Giving a barely perceptible start, he crawled on at first but stopped a second or so later and looked back over his shoulder. Then, moving slightly back, he rubbed his foot once more over the thistle. Next he turned to the plant, looked at it with intense concentration, and moved his hand back and forth over it. This was followed by a perfect control experiment: he looked round, selected a ragwort rosette and touched it in the same way. After this he touched the thistle once more and only then did he continue his journey . . .

We have chosen to begin with a set of quotations because we feel that they lead more effectively than any number of our own words could to the answer to the question posed above.

Children experience science from a very young age and are really quite good at it. To proceed otherwise than by finding out what they have been doing and then building on it is very unwise.

Even in the 1970s, children entering secondary school who had had much experience of science apart from nature study were the exception rather than the rule. There were several reasons for this, but perhaps the most important was that there were few primary teachers who possessed a science background. Many had opted out of science at an early stage of their own schooling–a reflection of the still-with-us problem which the SSCR was created to try to solve.

This situation is changing very rapidly to the point where we can soon expect that the vast majority of 11-year-old children will have a considerable amount of scientific knowledge and experience. Among the complex reasons for this are:

- the resources made available from the DES and LEAs to fund the appointment of Advisory Teachers for Primary Science under the ESG scheme, now taken up by the majority of authorities;
- the 90% funding available from the DES for INSET courses for Primary School Science Coordinators, designed to allow them to produce a policy for science for their schools;
- the interest and resources which many LEAs have put into primary science, usually through their advisory services;
- the increasing interest shown in primary science by learned societies, industry and similar bodies. Of particular note here is the upsurge of commitment by the ASE. At the time of writing, the Association is conducting a large-scale attempt to recruit new primary members and has just launched an ambitious journal — *Primary Science Review*. If this drive is as successful as is hoped it ought finally to cement the major place of primary science in the spectrum of science education.

In summary then, many more primary teachers are now qualified, confident and interested in science. This will result (is resulting) in a huge increase in the numbers of children leaving their primary schools having spent a significant proportion of their time on scientific matters.

Why spend time on liaison?

Most children now study science as a significant part of their primary curriculum. The secondary school surely has a duty to build upon this experience.

What of the child who enters secondary school? In what ways can more effective liaison between the primary and secondary sectors be of use to that child? In order to answer these questions, perhaps we should first look at the evidence we have that the present situation is indeed failing the children. *Improving Secondary Schools*) (The Hargreaves Report) (**0.3**) provides ample support for the view that all is not well, and we quote a statement from it concerning the primary–secondary transition.

> **3.3.2** *The worrying evidence of a decline in the rate of progress of some pupils, or even deterioration in others, is echoed by comments the Committee received from schools and other sources. In considering what schools are doing and what they might do to ease the problems of transition, it seems right to consider the following aspects: the transfer of records and information from one school to another; the induction of pupils into the secondary school; and the continuity in curriculum, teaching styles and classroom organisation.*

The Hargreaves Report identifies areas where the transfer from primary to secondary schools is going wrong:

> (a) *the contrast between the two views held by secondary teachers about the transition. The first regards the secondary school entry as 'a clean break', 'a fresh start' or a turning over of a new leaf which breaks free of previous teacher stereotypes. The second regards the entry to secondary school as an opportunity to build upon the past as quickly and as efficiently as possible; to move forward from the point at which the primary school left off.*
>
> (b) *that research has found that there was evidence to suggest a general difference in style between primary school teachers and the teachers in the transfer schools. A point reiterated throughout the research was that the teachers' style was a dominant influence on the way pupils behaved. This led to the creation of a category of pupils they called 'easy riders'. Such pupils sat well back to enjoy the 'ride', doing just enough to avoid the teacher's attention. In mathematics the great majority of pupils became 'easy riders'. 60% of the pupils in science were 'easy riders' and a quarter of all pupils adopted such behaviour across all subjects.*

Research indicates that secondary schools would have fewer problems with discipline or lack of commitment on the part of lower school pupils if they were to build more effectively on the curriculum which the pupils had encountered in their primary schools. We hope that the reader is convinced of the necessity of giving higher priority to liaison than hitherto. Perhaps the following quotation from *Science 5–16: A statement of policy* (**0.4**) will provide the final motivation:

> **32.** *The development of science in primary (or first) schools imposes an added responsibility on the schools to which the pupils transfer: they have to ensure, if the goal of making science for 5 to 16 a continuum is to be realised, that the pupils' early start is neither ignored nor undervalued but rather reinforced and exploited in their subsequent work. Suitable arrangements for ensuring continuity and progression are therefore essential.*

- Young children engage in scientific activity often long before going to school
- Primary schools now build on this with a significant part of their curriculum being used for the study of science
- More liaison with primary schools will allow secondary science teachers constructively to use primary school learning
- Links with primary school work mean children will take a livelier interest in lessons and will behave better

***Box 1** Reasons for creating continuity in science education*

We are convinced, but where do we start?

In our view there are four prerequisites for a liaison which is likely to be successful enough to improve both continuity and progression. These are:

1 A willingness on the part of the primary and secondary schools concerned to work together to improve the situation.
2 A commitment on the part of the staffs of all schools concerned to be sympathetic to each others' problems.
3 A commitment on the part of the local authority, governing bodies and parents to support the resource implications for the schools and for individual subject areas such as science.
4 For the science departments of secondary schools and for the staffs of their feeder schools, a commitment to each other's priorities and a willingness to allocate precious time towards the solution of the problem.

SECTION ONE

What are the problems?

SSCR involvement at the primary–secondary interface

The publication of Jarman's paper (**1.1**) on the involvement of the SSCR at the primary–secondary interface gave rise to a very brisk level of interest from teachers in both phases.

> *Within a single school, to encourage the physics teacher to talk to the biology teacher may well be a substantial task. To encourage the science department to communicate with the history department represents an even more daunting exercise. To attempt to cultivate effective liaison between the class teacher in a primary school and the science specialist in a secondary school ten miles down the road is an undertaking so monumental as to appear almost impossible. The justification for the returns from such an enterprise would need to be considerable to warrant the major investment of teacher time and energy which would be required for its achievement.*
>
> *What case can be offered by the Review for advocating that teachers in both the primary and secondary sector should come together to consider the fate of science studies across the transition and beyond? Or, and perhaps more important in the context of this paper, should the Review risk getting involved in such a perilous business at all?*
>
> *Dialogue between those involved in the teaching of science at primary and secondary levels can be seen as desirable (indispensable?) on at least two counts — one solidly pragmatic, the other rather more doctrinaire:*
>
> *1 The Prevention of Duplication;*
> *2 The Promotion of Continuity.*

In her conclusion Jarman makes five suggestions for further action, from which we quote the following:

> *1 . . . Perhaps, too, we should move to reopen the debate as to the role of primary science with respect to secondary science as part of the much broader consideration of what constitutes 'continuity' in science education.*
>
> *3 . . . SSCR should encourage (commission) a local working group to investigate ways of edging science teachers along the scale of attitudes to primary science from positions of 'confrontation' to those of 'cooperation'.*
>
> *4 A limited number of case studies will be produced, documenting practical steps which can be taken to overcome the barriers which stand in the way of effective liaison between primary and secondary teachers on matters of the science curriculum.*

The following section represents our attempt to explore ways of taking up some of Jarman's

important suggestions. It is presented as statements which epitomise the problems—the sort we have often heard from busy secondary heads of department – together with our thoughts on them. It is intended to raise some of the important issues in this area at the beginning of this Curriculum Guide, rather than to provide immediate answers.

Problems we can identify

> Primary teachers are usually not trained in science. Science is difficult enough for children and I would rather it was taught by someone who has had adequate training.

> Safety is important and children can only get proper safety education at secondary school.

> By the time they get to us they've done all the good experiments so that when we do them properly the children are bored.

> They are supposed to have done all this science, but when they come to us they can't even measure properly!

We believe that statements like these, all of which are genuine, are indicative of the widespread lack of knowledge of the primary school world. We could, of course, respond to them individually . . .

> Haven't you heard about the recent increases in the numbers of primary teachers now trained in science and of the ESG scheme?

> Safety matters in the classroom just as it does at the roadside. Surely the earlier safety education of any sort starts the better?

> If those experiments have been done at an appropriate age for the children's development then that is the right time to do them. You will of course bore most children by repeating them. Why don't you use the time released to do some of the work for which you've never previously had the time?

> Of course some aspects of 'scientific' measurement will be unfamiliar to them, such as the use of a really accurate balance or a mercury thermometer. If you want them to have these skills then you must teach them. But they *can* measure, and with great sophistication, for they will have spent time in all sorts of contexts (not just science) in the primary school developing their measurement skills. There really is no need to start again, unless you *want* to bore them!

More generally, one of the intentions of this Curriculum Guide is to give secondary teachers in particular an insight into the world of primary science, in the hope that by doing so the distrust and ignorance inherent in the first statements can be allayed. However, there are other sorts of statement that can often be heard, which have different implications.

> My school intakes from 47 different primary schools. How can anyone expect me to liaise with them all?

> Liaison in this school is difficult as my Head of First Year is not a scientist and is mainly interested in reading and number competence.

> The science they have done in primary schools is so variable in amount and content that we have to assume that they know nothing and start from square one.

These statements are no less genuine than the first set but are, of course, based on real knowledge of the secondary school situation. Even the many secondary teachers keen to build on primary science often voice these sorts of difficulty as reasons for not starting yet! This Curriculum Guide does not pretend in any way to be a panacea for this sort of ill, but it does attempt to set out some ways in which these sorts of difficulty may begin to be ameliorated. And ameliorated they must be, for the sake of children such as Anna Wilson (**1.2**), whom we describe in Box 2.

Will you foster this child for educational continuity and progression?

Name: Anna Wilson
Age: 10 years 9 months
School: Norstream Primary

Anna needs a home. She is 10 years old. Her present situation is such that she will have to move this September and will be looking for a family who could sustain her for a further five years. Anna is ready for a move. She has a lively, enquiring mind, communicates readily and has shown good evidence of a wide range of learning skills. By nature curious, she enjoys posing questions and devising ways of answering them.

Anna has already had one move in her life and although she has an attractive buoyant personality, she can be very sad, particularly in situations which inhibit her self-expression. Could you be the school family we are looking for? Tell us a little about yourself and if you would like to hear more about Anna, please contact Norstream Primary School, Upper Witton.

Box 2 *This child needs a school family*

Finally, we provide three more statements that we hope have not been heard too often by the reader.

I fear that I don't have the technician support to do all this problem solving.

I can't do very adventurous science when I am only allowed 80 minutes twice a week for science in the first year.

Science in the primary school is biased in the direction of life sciences. This problem is exacerbated in the lower secondary school as we haven't got enough physics teachers.

The aims of the SSCR and our purpose in writing this Curriculum Guide are founded on the belief that the best primary science practice is not only well worth building upon, but also represents a much better approach to science education than that so often provided in the early years of secondary school. Whilst not wishing to overstate the virtues of primary science teaching, we should all remember that it goes on admirably, even though:

- it is often taught by people whose initial qualification was not in the sciences;
- there is usually no technician back-up, no time set aside for marking and preparation, and a resource base far inferior to that enjoyed by secondary schools;
- the needs of primary-age children mean that science cannot be taught as a specific subject, but must be integrated into the whole of the curriculum.

We hope that this Curriculum Guide will be read in the spirit of wanting to build successfully on the best primary science practice in order to improve secondary science provision to such an extent that we remove for good the problems now so common further up the age range.

SECTION TWO

Science in the primary school

Organisation

Those readers who are not primary teachers may not have set foot in a primary school for many years. Those interested in liaison ought, we feel, to be well informed about the ethos, resources, organisation and attitudes towards science education to be found in the primary school, so that the continuum implicit in the idea of science education from 5 to 16 can be visualised.

The children

Children start school in Britain at 5 years of age, attending an infant or first school, often separate but sometimes sharing a site with a school for older children. This may be a junior school or a middle school in which the children remain until they are 11, 12 or 13 years old. These schools are sometimes combined, under one headteacher, as primary schools. It is worth noting that separate infant and junior schools, although on the same site, may have as much difficulty liaising with each other as do primary and secondary schools.

Class organisation

Children in the primary school are usually grouped by age, nearly always in mixed ability classes. Some schools have classes which are vertically grouped, that is, they contain children of more than one age group. Each class has a teacher who will remain with the class for the whole academic year. It is rare for primary teachers to have preparation periods in their timetables, and many face classes far larger than their secondary colleagues.

The Staff

The power in the primary school lies with the headteachers, who may have a staff of up to 16 teachers, supported by a deputy head who is often a class teacher. Posts of responsibility rarely cover all curricular areas, and are to a large extent under the control of the head. The extent of staff consultation will depend very much on the head's personal style. Many primary schools have a post-holder for science, but that responsibility may also be combined with another area like maths, environmental studies, CDT or something less appropriate like games. The posts in a school may be changed, especially in times of staff stagnation; this encourages the staff to attend in-service courses in the various curricular areas a primary teacher has to cover. Staff may also move up and down the age range, teaching 5 year olds one year, 10 year olds the next.

The post-holder for science

This person, in addition to other possible responsibilities as described above, may well be expected:

- to create the resources for science;
- to store, repair, maintain and check stock;
- to formulate a school policy for science;
- to keep staff up to date with new acquisitions;
- to be responsible for science-related safety matters;
- to generally advise and help other staff on matters scientific.

The post-holder may also be responsible for bidding for money for resources alongside other bids. The headteacher's practice in this area may be anywhere on the autocrat—democrat scale. Money for science may be supplied as a regular commitment or as a one-off. The post-holder may be given total freedom to spend allocated money as he or she wishes, may be asked to consult other staff including the head, or the head alone may decide how to spend it.

The resultant stock is often a problem to store, and of course there is no technician help. The compilers find it pleasing that many secondary school technical staff are prepared to assist, out of kindness, local primary schools struggling with a resource problem.

The post-holder will be expected to attend courses and report back to colleagues, setting up workshop sessions and introducing new areas such as design and technology, LEA initiatives or newly published material. Responsibility for initiating a school policy for science may also fall on their shoulders, or be developed by the whole staff led by the post-holder (see Section 3).

The post-holder is expected to advise staff on the planning and execution of science in the classroom, sometimes being released from class responsibilities in order to do so. In some schools where science is a new area, s/he may act as 'expert' and actually take science 'lessons' throughout the school. This would be a temporary measure until, hopefully, the class teachers could take over for themselves.

Science in the classroom

> *. . . the objective should be that all class teachers without exception, should include at least some science in their teaching, making use of their colleagues' knowledge and experience as necessary;* **(0.4)**

If this dictum is followed, all children should be provided with scientific experience by their class teacher from the day they start school. This will be an enormously varied diet in content, duration, quality and quantity and will also vary from year to year and from teacher to teacher. It may be based entirely on the interests of the children, on a radio or television series, on topic or thematic work, on a published scheme or on the school policy (see Section 3).

> *Much of the work in science should arise from the childrens' spontaneous interests and from their natural curiosity.*
>
> *. . . aspects of science that children should meet in the primary school should include the study of*
>
> (a) *living things and their interaction with the environment;*
> (b) *materials and their characteristics;*
> (c) *energy and materials;*
> (d) *forces and their effects.* **(0.4)**

We now wish to give the reader a flavour of the sort of science which goes on in primary schools. We shall see three very different teachers providing science for their children in the classroom. A primary teacher, having their class for most of the time for a year, knows them as individuals very well and has charted their progress in mathematics, language, movement and social skills and of course in science. He or she can allow the children's interest and enthusiasm for a particular

topic to flourish, can broaden its scope and increase its depth in a way denied to most secondary teachers, hidebound at present as they are by the demands of a syllabus, work scheme or the general constraining secondary curriculum. Indeed it is this very contrast which is most likely at the root of the liaison problems between primary and secondary science and is certainly a major contributing factor to the complete 'switching-off' from science of many secondary children.

We now present three very different tales to illustrate the variety of contexts in which scientific work can be identified in the primary classroom. The first example (Box 3) is an account of a morning's work of a postgraduate student on her final teaching practice.

Having read the children the story of *The Three Little Pigs* I explained exactly what I wanted them to do. I would divide them into groups and each group would have a different set of materials. Each group then had to build the best house they could. I had prepared tables with straw, twigs, string and sticky tape; paper, card and glue; building bricks; Lego; sand. A seventh group went outside with a helper to look at the school building to see how many different materials the school was made of. I was asking a lot of these 5-year-olds, but they worked well together despite the odd argument and produced some remarkable structures. They all discovered how difficult building really was! I asked each group in turn to show us what they had built, to tell us what problems they had encountered and how they had overcome them. In addition we all discussed how each structure would behave if it rained, was windy or was very hot. It was a very satisfactory session. The class listened intently as each group described their problems and applauded the results. The straw and twig groups had the hardest task. The straw group found that at least twigs are rigid and can be snapped to change their length. First attempts at some sort of log cabin had been abandoned in favour of a wigwam shape (with some assistance from the helper). The string and sticky tape were deemed essential as a means of holding it together. This structure would also be draughty, cold and wet, and many of the class suggested we put something over the twigs to keep out the wind and rain. We digressed for a few minutes to talk about Indian teepees and then looked at the house made of sand. This was like a cave, draught-proof except for the door, shady, would keep the rain out, but would be cold without a fire. We were getting onto the finer points of house-building now; Rupert said there were no windows and when we pushed holes in the walls the house collapsed; it was unstable. A small watering can showed us what would happen if it rained – the sand did not stick together and was not thought to be suitable building material. The group with paper, card and glue had much more success. Roxy and Katy had produced their own two-dimensional version, conventional in shape, with door, windows and chimney. The rest had managed to erect three walls and a roof on a card floor; the roof did not quite fit and they could not put the fourth wall on because they needed a hand inside to hold it steady! The group were so involved with the problem of support that they did not want to break off and show it to the others. The need for supports was discussed generally, the class suggested rulers and we looked at the great beams across the classroom ceiling. Buildings clearly often did need to be supported.

We then looked at the brick houses. The one made of building bricks had high walls and windows and a space for a door, but no roof. No brick was big enough to span the exterior walls. Again we discussed supports, but then someone knocked the house and it fell down. 'Bricks need cement or glue to hold them together,' was the consensus. The Lego of course required no glue; doors and windows as well as roof pieces contributed to form a sophisticated house.

The last group showed their wax rubbings of the school brickwork, and their list of materials in the structure of the school — bricks, cement, metal, wood and glass for windows, tiles for the roof. We looked at the way the bricks were laid on one another and we built Lego walls in the conventional pattern to see how stable they were. The morning had to end there, but it was clear that we could have done a great deal more investigation; testing the strengths of materials, finding different materials, etc. However, the children's interest did not stop there, for over the next few days several of them brought in houses made at home, and wet playtime was spent constructing houses out of whatever scrap they could lay their hands on.

***Box 3** A reception class at work*

Science work in primary schools is very often organised on a topic basis. Although much topic work *does* contain a scientific element, we should be wary of schools whose policy is that *all* science should arise from topic work and in these cases we need to look very carefully to make sure that science is indeed being covered. Box 4 shows how a teacher working through a topic that is scientific in its very nature can maximise the science element. This example is fictitious, and encompasses elements collected from observing many primary teachers at work.

It is the beginning of the autumn term, and the class teacher has planned a topic on fruits and seeds, and then takes the class out to the local park for a collecting session. But the visit to the park doesn't go quite as she expected; the overwhelming interest shown by the children was for those seeds that fly through the air. So... she decides to modify her plans and follow the childrens enthusiasm.

The next practical session starts with the whole class and the teacher discussing their outing to the park, and investigating their collections of seeds. Some children wanted to look at the floaters, dandelion and rosebay, thistle and bullrush. Others

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wanted to look at the spinners, sycamore and ash keys. Miss Dean gathered the children together and asked them to think about the questions they could ask their seeds, and how they could find out the answers.

She wrote their questions on the board.
Why do some seeds fly?
What holds the flying seeds up?
Would they fly without the seed? without the wing?
Does it matter if the wing or parachute is damaged?
Do they spin better in ones or twos?
Do they always spin the same way?
Could the seeds be heavier?
What would be the best seed? one that stays up for the longest time? one that spins the most? one that carries the heaviest seed?

The why? question she felt they should all tackle together ... so she threw it back to the children. 'Why do YOU think some seeds need to fly' and she got a variety of answers.
'Because they are ripe.'
'To get them off the plant.'
'Because they have wings.'
'So that they can fly a long way.'
'Alright, settle down, lets have a look at these ideas', said Miss Dean. 'What happens to ripe seeds...does anyone know?'
'Sometimes they get eaten,' said Sarah.
'They grow into new plants,' said Tony.
'Do you think the sycamore seeds get eaten?' said Miss Dean.
'No, they fly around for ages, even after all the leaves have gone,' said Sean.
'What would happen if the sycamore seeds all just dropped off the tree, and didn't fly at all? said Miss Dean.
'I know, I know' said Mervyn, 'all the baby trees would grow under the mummy tree.'
'Would that be a good thing?' said Miss Dean.
'Perhaps the Mummy tree would shelter the babies,' said Tommy.
'I think that they would be very crowded, we saw THOUSANDS of seeds, didn't we?' said Emma.
'Perhaps that's it,' said Malik, 'the seeds need to fly to get away from the mother tree, you know, to get more space.'
'So what would the best flying seed do?' said Miss Dean.
'I think it would be the one that stays up for the longest time, then it would travel furthest,' said Jehan.

Now Miss Dean asked the children to look at the other questions, those questions that can lead children on into investigations, and asked them to choose one to work on, and to find someone else to work with. They rapidly sorted themselves out, and moved so that they were sitting next to their partner.
'I suggest that you write down your question in your rough books, think about it for a minute or two, and then write down what you think the answer is going to be.' Winston said that there wasn't enough room in the class for them all to move about, and suggested that they move the tables back to the walls. Miss Dean said that they could also work in the corridor outside the class as long as they didn't make too much noise and disturb other classes.
'I am going to give you about 30 minutes for your first investigation, then we will talk about what you have discovered' said Miss Dean.
'Let's put the timer on for half an hour!' suggested Joanne.

There followed half an hour of intense activity, lots of discussion, lots of involvement.
At the end of the half hour Miss Dean stopped the children, with some difficulty, they were so involved, and asked for comments.
'It was ever so difficult to watch the seeds, Miss, they are ever so small', 'and they move so fast,' 'and if you break the wings you can't put them back again, can you?'
'This seems to be a problem that everyone is having,' said Miss Dean, 'Can anyone think of a way that we can overcome it?'

Jehan (hesitantly): 'we could make models, Miss...'
Teacher: 'What could we use instead of the real thing?'
Tom: Paper, paper for the wings, we have got all sorts of paper in the classroom.'
Pamela: 'What about the seed, we need something a little bit heavy.....I know, plasticine!'
Emma: '... or clay.'
Brad: '...or marbles.'
Teacher:'Well; you seem to have lots of ideas. You can have the rest of the afternoon to follow them through. You know where most of the things you want are stored, take care with the scissors when you are moving about, and try to remember not to cut you shapes out of the middle of your paper! I shall come round and help you all and see how you are going'.

The groups of children started work again, and soon found that a paper model was indeed easier to see, and much easier to experiment with. Initially most of them tried to copy fairly exactly the shape, size and weight of the original seed but soon they started to branch out. Some children looked at several different types of paper, some made wings and parachutes different sizes, some tried altering the weight of the 'seed' or altering the basic shape. As she went round talking to the children her advice was sought on a whole variety of problems, 'Can we stand on the chairs to drop our seeds Miss, they go better if we do?' 'Can we have a timer, we want to see if this big one goes quicker than this little one, Barry thinks it will but I don't!' 'Why is that then Anna?' 'I think the big wing presses on the air more than the little one.' 'Will that hold it up more, or let it drop more rapidly?' 'I think it will hold it up more, Barry thinks it won't!' Half an hour before the end of the afternoon session Miss Dean called the class to order, models were saved, rubbish cleared up and scissors, rulers, timers, etc., replaced in the storage units. When all was tidy she asked the children how their investigations were going, whether they had got any answers to their original questions?

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Mervyn: 'We discovered that the seeds fly better in ones than twos.'
Teacher: 'Any idea why?'
Mervyn: 'Well, me and Alice thought it might be something to do with the two wings getting in each other's way... but they (the real seeds I mean) break up easily into ones and then they fly really well.'
Sara: 'We tried cutting bits out of our wings, and we found that our seeds flew beautifully if the wing had lots of holes in it.'
Teacher: 'Did that surprise you?'
Sara: 'Yes it did, we thought the air would all escape.'
Brad: 'We found that floppy tissue paper was no good at all, for a big seed, but not too bad with a little one.'
Teacher: 'What can you conclude from that then, Brad?'
Brad: 'You have to have the right paper for the right sort of seed, um weight, um I think it's weight.'
Teacher: 'Did anybody else find results like Brad and Emma?'
Tom: 'We have made a giant one, can we let it go from the top of the stairs, Miss.....big wings need to fall a long way.'

The day's session came to an end, and although Miss Dean could see that there was much more investigation to be done, she also felt that it was time that the children organised their data in some form or other. So on the following day the children gathered together all of the information about flying seeds, some groups made books with descriptions of their work, drawings and models included. Other children joined together to make a graph to show the length of time the various models stayed in the air. Other children worked with the teacher to produce a short presentation of the work they had done for the class assembly, which was due that week. In the following weeks work continued on the theme of flight, and alongside it, the teacher's original theme of seeds and fruits.

Box 4 *Treatment of a primary school science topic*

The final example is also fictitious, but is drawn from personal observation of practising primary teachers. The example comes from a school which has adopted one of the published schemes for primary science, the *Look* scheme published by Addison-Wesley (**2.1**). This scheme provides a series of work cards suitable for the primary age range covering topics like 'Ourselves', 'Colour and light', 'Electricity', 'Hot and cold' and 'Forces and movement'. The class teacher in this example has little confidence in his ability to teach science and relies on work from the scheme to cover the science slot in his timetable.

Travelling seeds
13A
Please ask for
parachute seed e.g. dandelion
wing seed e.g. sycamore
burr
apple
spoon
20 pea pods
Seeds need to travel away from the 'old' plant so they have room to grow into a 'new' plant.
How do seeds travel?
1 Some seeds travel on the wind. Take a parachute seed outside. Hold it high up then let it go.
2 Try the same test with a wing seed.
3 Take off the parachutes or wings. Drop the seeds again.
Q1 Did the wind blow the seeds away from you?
Q2 Did the seeds blow as far without their parachutes or wings?
TURN OVER
13A Ourselves, Animals and Plants Look!

Fig. 1 A Look *workcard* (**2.1**)

The children work through the cards on 'Ourselves, animals and plants'. They are grouped in fours and fives and spend one session on each card. All the resources needed for the cards have been accumulated by the teacher and the children record their work in their science books. One of the work cards is shown in Fig.1.

The children copy the questions into their books and then fill in their answers from their practical experiences. On the whole the children can manage the activities suggested on the cards and work through them fairly quickly. They know that they are expected to complete one card in each science session, so pace themselves accordingly, illustrating their answers with careful drawings. The teacher is very pleased with the scheme because it gives him an ordered framework for science, which he used not to cover in his class at all. As the children work on the cards he moves around the class helping children with the reading and the suggested activities.

Box 5 *Primary science using a published scheme*

These three examples have given a sample of the variety of ways in which science may be taught in the primary school. The styles of the teachers concerned vary, as will the expectations of the schools. Are the examples really showing children doing science? What should you look for when visiting a primary classroom so that you can judge

whether science education is taking place? Some of the specific questions you should be asking include:

- Are the children making close observations, classifying and sorting, measuring and estimating using a variety of equipment, both commercial and home-made?
- Are they measuring height, area, weight, volume, temperature and other things?
- Are they investigating, finding out, designing and testing, controlling variables and making hypotheses? Are they cooperating, persevering, showing responsibility and sensitivity, enthusiastic and confident?
- Do the children talk to each other, work in a variety of combinations?
- Does the teacher spend time discussing the work with the whole class, a group of children or the individual child?
- Are the resources openly available for the children to get what they need and replace when they have finished?
- Are examples of children's work, displays, working models, collections, etc. given predominance over commercially produced charts and pictures?

If a few of these skills, processes and attitudes are being fostered in the class you are visiting, then the opportunity for science is there. If the content of the work can be placed in the categories defined by the DES as suitable for inclusion in the primary school, e.g. living things and their interaction with the environment, materials and their characteristics, energy and materials, forces and their effects (**0.4**), then surely science is being taught there.

SECTION THREE

Primary science policy statements

This section looks at primary science policy at the two levels of the school and the LEA.

At school level

> *. . . all class teachers, without exception, should include at least some science in their teaching . . .*
> (**0.4**, para.20)

The staff of a primary school are expected to teach all areas of the curriculum. Since 1975, and more particularly since the publication of the discussion document *Science in the Primary Schools* (**3.1**), science has been recognised as an area which has been neglected. The majority of teachers in the primary sector are women and their qualifications in science are usually in the biological field. Very few primary teachers have formal qualifications in the physical sciences. The importance of giving children a broad and balanced programme of science has been recognised by many schools, not only for the science content, but also for social reasons. The strengths of such a programme are seen as the opportunities it gives for cross-curricular links and the development of skills, the opportunities it gives to the non-academic child, and the encouragement it gives to the development of a scientific and problem-solving approach to the experiences of life. Schools are thus in a dilemma. On the one hand they receive messages, from HMI and elsewhere, about the importance of science. On the other hand it is difficult for them to know how to implement the teaching of science in the classroom. Ideally, all teachers have to come to some understanding of the nature of science, but they need to place it in the context of the primary school with the education of *every* young child in mind. There are few external constraints on the content of science in the primary school, nor indeed on the way in which it is taught, except in some LEAs. So decisions have to be made within the school about the philosophy and content of the science component within the overall programme, its progression and the records which will be kept.

The following selection of policies shows some of the variety produced by schools. The policies included are of two very different types, those produced by an LEA and those produced by a single primary school. The LEA policy is sometimes produced by the local science adviser, but more often by the adviser working with a group of interested primary teachers. This sort of document usually examines the philosophy of primary science and how the LEA sees that philosophy fitting in with the schools in the area. It may give broad content guidelines, ideas for recording and assessing children's progress and, in some LEAs, may lay down a method of assessment. It may recommend a commercially available primary science scheme. Indeed, some authorities go to the lengths of buying in a scheme for all local primary

schools and of providing the necessary resources for schools to operate that scheme. Some LEAs have produced their own curriculum development materials to be used by schools. Examples of these include Derbyshire and West Sussex.

> *The (policy) should . . . be drawn up as a result of discussion between the Head Teacher and all of the staff . . .* (**0.4**, para.29)

The policy produced by a single school may also stem from more than one type of origin and may take one of two different forms.

1 The policy may be written by the headteacher, the teacher with a post of responsibility for science, often a Scale 2, or the two in partnership.
2 The policy may be written by the whole staff of the school after a series of staff meetings spent discussing the issues involved.

The documents produced by either of these means may be a statement of the philosophy of science held by the staff to be appropriate at primary level, a school programme for science, or some mixture of both. It is very unlikely to be a syllabus, in the accepted sense, containing a prescribed progression of content.

Primary staff have to create a balance when developing a policy for science between the DES's stated objectives for children to 'gain a progressively deeper understanding of some of the central concepts of science' and (almost in the same breath) that 'much of the work should arise from children's curiosity'. A primary school whose staff work together to provide a stimulating and interesting child-centred environment will find these two seemingly conflicting statements far easier to cope with than a school which allows the needs of the secondary school – or any other outside constraint – to rule its curriculum.

We have chosen four documents produced by a selection of fictional and real primary schools to illustrate the range of possible approaches.

1 **Honeywell Infants School.** This is a policy statement written by the headteacher.
2 **St Jude the Obscure Junior School.** This is a statement produced by the teacher with a scale post for science.
3 **Cubitt Town Infants School.** This is a policy produced by whole-staff discussion.
4 **The Boutcher Primary School.** This policy has also evolved from whole-staff discussion.

Honeywell Infants School

Honeywell Infants School is a small school of about 130 children situated in a comfortable suburb. It has experienced a large drop in intake over the last few years and consequently has lost teachers through redeployment. Most of the present staff have only been in the school for one or two years; the headteacher has been in her post for about four years. The deputy head has organised the science resources for the school in her room, which is one of the larger classrooms, and staff have free access. The headteacher wrote the policy in order to help her rather transient staff provide a balanced education for the children in their care.

The statement (Box 6) is clearly based on the philosophy of the *Science 5–13* Schools Council Project and is firmly wedded to the actual practice in the school. Teachers are expected to provide at least one science-based topic per year and also are expected to recognise and exploit the opportunities for scientific work in other topics that they cover. As yet no ways have been devised for the staff to record the children's individual progress in science. Some teachers keep gerbils in the classroom and many grow plants – there is a small school garden which the children help to look after.

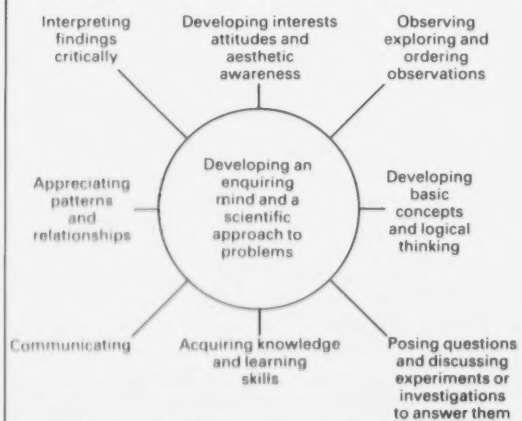
HONEYWELL INFANTS SCHOOL March 1982.

PRIMARY SCIENCE

The study of science has always been part of the Infant school curriculum. From time immemorial all classrooms have possessed Nature tables, and experimentation with sand, water, bricks, colour, measures, etc. have been a natural part of the children's experience. Recently however the concern has been to broaden this experience and to explore the scientific processes in greater depth.

Aims

The aims of primary science are summarised in the chart below taken from *Science 5–13*.


Interpreting findings critically
Developing interests attitudes and aesthetic awareness
Observing exploring and ordering observations
Developing an enquiring mind and a scientific approach to problems
Appreciating patterns and relationships
Developing basic concepts and logical thinking
Communicating
Acquiring knowledge and learning skills
Posing questions and discussing experiments or investigations to answer them

The development that we are hoping to foster when children question, investigate and form ideas about their environment is a mixture of strands which can be described as processes, attitudes and concepts. Through observing and attempting to interpret observations children learn how certain things behave, and this knowledge is brought into play when similar phenomena are encountered, resulting in confirmation, extension, or modification of the earlier ideas.

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All infant children love to work at the water tray. Early in the Nursery school, children observe that objects with holes sink, they then think that all objects with holes will sink and are surprised when a tin lid with a very small hole in it floats. To begin with they will often purposefully sink the lid so that it follows the idea already formed. With encouragement from the teacher they will explore the notion further until by 7 years of age they have modified their original notion and are gaining some understanding of surface tension, air pressure, etc. Concepts like these take a long time to develop and children need to return to experiments involving floating and sinking frequently and gradually refine their ideas as they grow older.

In the Infant school science is seen as part of our integrated approach to children's learning not as something separate to be introduced as a subject area. Science is included as part of the project work undertaken by each class. Obviously some projects will lend themselves more readily than others to the exploitation of science. However all will incorporate aspects of the science process even if content areas such as electricity are less clearly defined. In order to ensure that the children have a balanced curriculum the class will undertake at least one science biased project during the year and certain content areas, suitable for children of Infant age will be deliberately introduced.

Science Processes
In the Infant school, when children are beginning to understand themselves and their environment, science processes assume more importance than content areas. These processes can be seen in 3 stages:-

STAGE 1

Observing	Describing
Measuring	Classifying
Comparing	Recording
Investigating	Communicating findings

STAGE 2
Constructing hypotheses
Predicting
Interpreting data

STAGE 3
Controlling variables
Experimenting

These stages represent not only an increasing sophistication for children but also an order of the teachers involvement in the children's learning. Most Infants will need help with Stage 3 processes, and recording throughout the stages will tend to be minimal as most communication will be verbal.

Science Content
Within limits what is actually found out is not important, as the main value lies in the process of finding out. The content of the science curriculum will depend partly on capitalising on these activities generally made available to the children, partly on project work and partly on those aspects of science which we hope all children will experience during their Infant school years.

Science in the class environment
Experimenting and exploring around:-

Water	Nature study
Sand	Materials
Measures	Colours

Science introduced by the teachers
The Natural World
Lenses and mirrors
Magnets
Electrical Circuits
Ourselves
Growth
Time
Water
Materials and their properties

Science related to project areas
These will vary throughout the school, however one project in each class will be deliberately chosen because it has a science bias. Projects undertaken this year have included:-

India
How the world began
Colour
Growth
Our bodies and ourselves
Flight
Time
Expeditions
Our senses

***Box 6** Honeywell Infants: statement of policy*

St Jude the Obscure Junior School

St Jude's is a small church school. The newly appointed head is conscious of the need to broaden the school's curriculum, which has been largely based on the three Rs. The building is old, but the classrooms are large and light with classes of around thirty children. The headteacher sent the teacher with a scale post for science on an in-service course for primary science, and asked her to write a school policy for science on her return. The teacher has a science background and takes the top junior class; her children receive a regular science lesson. The policy was dictated by the set of work cards that the school had already purchased (Box 7) and the packs of resources that went with them. The resources were stored in a science trolley which was kept locked up in the school stock room. Members of staff who wanted to use the equipment had to approach the post-holder well in advance so that she could go and sort out the apparatus needed. Science topics that were allocated to each year did not necessarily fit in well with topics in other areas of the curriculum. There are some animals in the school, but no opportunity for gardening in the school grounds.

First-year topics
- Ourselves
- Experiments with water
- Simple experiments with magnets
- Experiments with living plants
- Study of animals
- Environment

Second-year topics
- Experiments with air
- Experiments with growing plants
- Ourselves
- Animals (collected from the environment – 'mini beasts' – life cycles)
- Experiments with water
- Experiments with dissolving and evaporating forming crystals

Third-year topics
- Ourselves
- Energy
- Study of forces (including simple machines – levers, wheels and cogs)
- Magnets, compass, electromagnets
- Temperature – hot and cold
- Growing things
- Animals

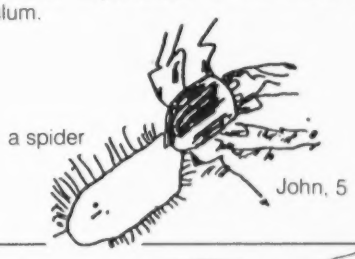
Fourth-year topics
- Experiments with light
- Electricity
- Springs
- Pulleys
- Ourselves
- Living things – animals and plants

***Box 7** Work cards dictating policy*

Cubitt Town Infants School

This school is situated in an industrial area, presently undergoing a great deal of redevelopment. Most of the children come from the local council estate and most attend the school nursery class. The school is full of animals and plants. This policy (Box 8) was written in 1983, after a great deal of discussion by the entire staff of the school (it is very interesting to look at *Science 5—16: A statement of policy* (0.4), particularly at §§11, 12 and 13, when looking at the aims and objectives in this school-produced document). The staff have been implementing this policy for nearly three years. They are about to start discussing the formulation of a checklist for science experiences and expect that it will take them some time to reach agreement. Most of the teachers work to a half-termly theme, which inevitably has a science component. The science resources in the school are nearly all out in the classrooms. Each class has a small stack of trays containing magnifying glasses, magnets, tuning forks, acetate sheets, lenses, pooters, the components of an electrical circuit and filter paper. The more valuable equipment like microscopes, lenses, prisms, etc., is kept in the science cupboard and is available to all staff. The classroom stacks are open; the children are able to go and take equipment as and when they need it and are expected to replace it when they have finished with it. (See box 8 below.)

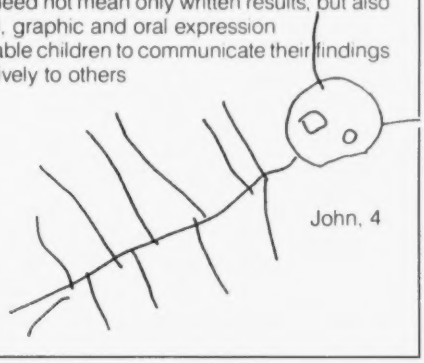
Introduction
Science for young children should be very natural and simple. It is exciting because it concerns their world and finding out about it in all its aspects. This would include the immediate environment, themselves, and the way things live and work. With Infant children on the Isle of Dogs science must be approached, and put into practice, from first hand experience and observation.
Science fosters specific attitudes of mind — curiosity and discovery — and skills of perception, interpretation and evaluation of how the world works. As such it should be considered as worthwhile as other valued experiences in the Infant school curriculum.



Aims:
Our aims are:
1) to develop science as an integral part of the curriculum, which will include linguistic, mathematical and aesthetic development, but which will also require specific scientific skills
2) to present first hand experiences of the children's immediate environment which have meaning and relevance for them, encompassing worthwhile and valuable experiences appropriate to the individual child's ability
3) to encourage discussion at all levels
4) to involve children in experimentation; to give them confidence to formulate and follow up new ideas; to record results, and be able to test and evaluate those results
5) to provide access for children to communicate their discoveries through refined and precise terminology. This means using technical language
6) to help children develop discrimination and awareness that decisions have to be made regarding the moral and social implications of scientific and technological investigations at a level appropriate to their understanding and insight
7) most importantly of all, to further a child's sense of natural wonder of the world around and value each child's emotional response

Objectives

a) to develop skills of careful observation and practical enquiry, appropriate to the age and ability of each child
b) to enable children to gather and classify information
c) to develop relevant questioning and other skills required for discussion
d) to develop appropriate language and enhance scientific vocabulary
e) to encourage an awareness of variables influencing results, and enable children to predict and hypothesise
f) to enable children to record their findings clearly. This need not mean only written results, but also visual, graphic and oral expression
g) to enable children to communicate their findings effectively to others



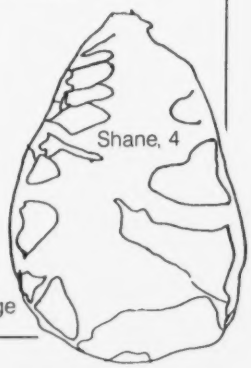
a beetle

Organisation

Infant teachers are not expected to be 'scientists', and they may be apprehensive about science. This can be a positive asset with Infants, because teacher and child can learn together.

Teachers need not feel they are the only resource : one's own knowledge of science can even be extended by using children's publications that lay out ideas clearly and with relevant information. A teacher's major skill is to draw out the ideas, make them clear, and re-inforce them for the children.

Science is already present within an integrated curriculum. A number of teachers might not be aware that many of the activities they already do with their children are of a scientific nature.



transverse section of an orange

Organisation

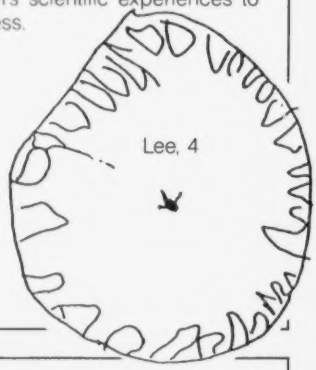
Teachers need not alter their organisation radically. Start small and simple.

Don't embark on a major science 'extravaganza'. To set aside an afternoon a week for 'science' would diminish the part that science plays in their children's experiences.

Not all children will feel confident to take part in all areas of science, but centres of interest may be beneficial in encouraging curiosity and participation.

All children should be included in these areas, but activities and approaches may need to be modified.

Teachers need to be more aware of extending and enriching their children's scientific experiences to allow all children success.



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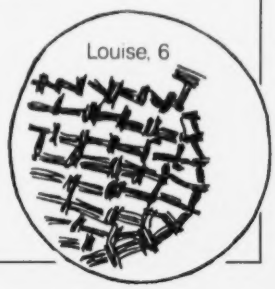
Organisation

It is important that teachers and children are prepared. Being aware of the next stage, and then moving on to it, is crucial, as is being able and willing to take in the children's own ideas.

Through discussion children will learn the skills of listening, sharing ideas, giving opinions, and modifying views.

Good discussion is highly complex and needs a great deal of thought and preparation for its effective organisation.

As in other areas of the child's development the growth of discussion skills needs time and practice.



cotton material through a microscope

Evaluation

How do we assess a child's scientific ability and understanding? Before attempting evaluation it is necessary for a teacher to have a clear idea of the methods and content to be used to achieve the stated objectives.

Evaluation might then be achieved through observation of individuals; group activities; use of a check list; or questioning and analysis of a child's response.

Evaluation and regular revision are necessary so that alterations and modifications can be made to accommodate the flexibility of individual teachers and differing needs and abilities of the children.

To maintain continuity in a child's education it is important to show that a child has had some experience in acquiring the skills outlined in our aims and objectives.

This can be indicated on the LEA records, and may be accompanied by some evidence of areas covered.

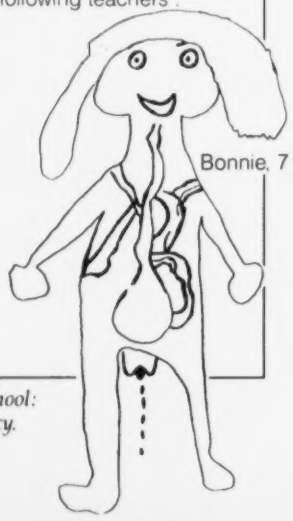
This science policy is a practical document that reflects the work that is being carried out with our children in this school.

Starting points for themes of work in science, reference materials, suggestions for approaches, as well as books and documents, are available in the staff Library in the staffroom. There is also a great variety of ideas contained in children's science books in the school Library.

This policy has been compiled as a result of a great deal of discussion by the following teachers :

Eve Harrington
Carolyn Blakemore
Sally Maidment
Laura Holden
Joan McMahon
Andrea Barratt
Christine Adams
Peter Hall
Jackie Gale
Judith English

Bonnie, 7



***Box 8** Cubitt Town Infants School: a booklet of science policy.*

The Boutcher Primary School

The Boutcher Primary School is situated in a very poor inner-city area. It is a church school and has very cramped and ancient classrooms, but a new hall and dining room were built a few years ago. The headteacher has been at the school for four years and has a stable and dedicated staff. The local authority run an in-service training scheme for primary science and two of the school's teachers attended the two-week-long course. On return to school one of the teachers took on responsibility for organising the school's resources for science, although it was not possible to give him a Scale 2 post. The resources were organised in a room set aside for the reading schemes, the maths equipment and the musical instruments. The primary science adviser was then invited to come to the school to run workshops for the staff, with the aim of introducing them to the resources and helping them gain confidence in their ability to plan a variety of science topics. This went on over a period of about a year, and when the head felt that all the teachers had made a start with teaching science, the long evolutionary process of formulating a policy began. Again the services of the adviser were called upon to participate in an initial meeting at which all the members of staff were to air their feelings about science in the primary school. The eventual aim was to reach a consensus about the aims and long-term objectives of a school policy. The staff had already tackled other curricular areas, and had reached agreement on the general approach to education in the school. This was to be very much a child-centred approach, starting from the individual child and working out to include the home and the school, and then the local environment. Science fitted in well with this philosophy and teachers were identifying possible scientific experiences they could give the children using a variety of starting points. They considered several work card schemes, and decided in the end to use a variety of printed materials to support their work. As teachers and children became familiar with the resources, it became evident that each class needed a set of basic resources which would be in almost continuous use in the classroom. The carefully organised and stored resources spent more time out in the classroom than in store.

The written part of this school's policy (Box 9) is merely the tip of an iceberg; the majority of the work is invisible on paper, but evident all around when you visit the school. For interested readers, a video of work at this school is also available (**3.2**).

Science Policy

What is Science?

Science is the development of objective investigation (open mindedness) from either the child's own practical experience or his/her active exploration of the environment in which they live.

The attitudes and enthusiasm of the staff are of great importance in this development. Class organisation and the proper use of resources are paramount in achieving the above. The school should make provision for the development of science within the curriculum. This is achieved by promoting observation, hypothesising, enquiry and experimental skills (testing of their own discoveries). Scientific skills will be developed during this process.

This Policy has been discussed and formulated by the staff of Boutcher School with equal consideration being given to the development of attitudes, skills and concepts.

ATTITUDES

- Open mindedness
- Perseverance
- Curiosity
- Confidence
- Sensibility to living things
- Responsibility for the environment
- Co-operation
- Originality
- Critical awareness
- Interest in some discovery, to develop and pursue
- Awareness of man's influence on the environment

Measuring/Recording
accurate measurement skills, graphs, Venn diagrams — pictorial representation, estimation, models, etc.

Ecological
handling of insects, etc., classification skills e.g. plants.

Speculation
evaluative skills — methods of devising a fair test.

SKILLS

Manipulative skills
1. Fine adjustment of the microscope.
2. Handling of other equipment.
3. Electrical circuits.

Social
group interaction — language intervention; personal responsibility to group working as a group or individual sharing experiences.

Observational skills
1. looking for patterns and relationships.
2. interpretation of patterns.
3. objective or subjective technique.

Enquiry
relevant questions; how to use printed information e.g. indexes, contents, etc. skimming and scanning; note taking.

KEY SCIENCE CONCEPTS

Four major concept areas:-

Living things
1. Animals and plants –
2. Classification of living things – why classify?
3. Cycles – food chains, life cycles, etc. reproduction.
4. Change – change and its effects on living things.
5. Interdependence – symbiosis, etc. parasites.
6. Adaptation of living things – e.g. breathing on land/water. Evolution.

Energy
1. Types of energy – e.g. potential, kinetic, heat, light, electricity.
2. Energy changes – e.g. light/heat – light bulb. sound/electrical – telephone.
3. Energy resources
4. Energy movements – e.g. light – travels in straight line.

Structure, materials and their properties
1. Cause and effect – movements.
2. Force – weight, magnetism, gravity, etc.
3. Measurements – e.g. time.

Environment
Space – Atmosphere.
– Planets.
– Weather.

***Box 9** The Boutcher Primary School policy*

At LEA level

We have conducted a reasonably exhaustive survey of LEA policy statements on primary science from the collection of LEA statements made by John Heaney (SSCR Regional Project Officer, Midland Region). Heaney's collection is not complete, though the vast majority of Local Authorities have issued a policy statement since the DES Circular 6/81 requested them to do so.

We would advocate that any reader of this Curriculum Guide ought to obtain a copy of their Authority's policy statement and examine it to discover the position of primary science as policy for them. We can do no more here than to:

- forewarn about disappointment, for some LEA statements are so generalised as to be of little use to the classroom teacher;
- illustrate from some of them the variation in practice in the hope that this may be of more general interest.

For the purposes of this Curriculum Guide, there are four facets of LEA policy statements worth examining:

1 the general approach to the task;
2 what picture of primary science, and of the whole science curriculum, emerges;
3 to what extent the science curriculum is treated as a coherent part of the overall curriculum;
4 whether, and to what extent, the policy statement deals with issues of liaison across phases of education.

Approaching the task

The statements vary considerably, both in the detail with which they elaborate the curricular aims, and in the way in which they present them. Perhaps the most common format consists of a general introduction followed by a series of separate statements on the curriculum. Yet others contain a large number of quotations from DES policy statements, circulars and the like. Length varies from perhaps two thousand words upwards. Perhaps the contents page given in Box 11 below best epitomises the sort of document the reader might expect to find.

1 Introduction 2
2 Why do science? 3
3 Producing a science policy for the school 4
4 Which concepts should be taught? 5
5 Which skills should be developed? 8
6 Some suggested activities with references 9
7 Resources, suppliers and published schemes .. 29
8 Evaluation and record keeping 34
9 Members of the group 37
10 Acknowledgements 38

***Box 11** Contents list from Norfolk County Council* **(3.3)**

What picture of science?

This varies from the didactic, or at least centrally dictated:

> *The child should be taught:*
> *to speak with clarity, fluency and understanding;*
> *to speak and listen with concentration and understanding;...*

to the gently guiding (Box 11)...

Having ascertained the need for a curriculum, the next stop is to determine the aims.
Suggested aims:
1 To help children to develop an awareness of and pleasure in, the world around them.
2 To help children to develop a sense of curiosity and enquiry.
3 To help children to learn about living things, non-living things and natural phenomena.
4 To help children to develop an attitude of care and responsibility.
5 To help children to acquire some understanding of patterns and relationships.

Aims are an integral part of good teaching only if they are implemented in the classroom.

This can be achieved by a process of thinking which extends an aim THROUGH a variety of experiences BY a range of activities.

***Box 11** Norfolk County Council* **(3.3)**

...to the statement of principle (Box 12).

Science and technology

5.7

(i) develop an attitude of enquiry toward the physical and living world and awareness of applications of science through technology and other fields;
(ii) develop a progressively higher degree of understanding of important scientific ideas and principles;
(iii) practise the skills of a scientific approach to problems including observing, generalising, suggesting explanations, making predictions, devising and performing experiments, developing practical skills, taking decisions and applying what has been learned;
(iv) develop an appreciation of the scope of science, not only recognising the areas of physics, chemistry and the life sciences, but also developing some knowledge of the environment and earth sciences, astronomy and modern technologies in appropriate contexts;
(v) learn through a course in which aspects of science are interrelated to each other as far as possible and related to the child's world of today and tomorrow;
(vi) begin to develop an awareness of the moral and social implications of science and technology and an appreciation of these fields as human pursuits.

***Box 12** Humberside County Council* **(3.4)**

Science and the whole curriculum

How this is dealt with can often be a reflection of whether science is given a separate section, or even a separate document, to itself. Sometimes, as in the case of the Humberside statement (Box 13), science is so well integrated as effectively to disappear.

4 ANALYSIS OF THE CURRICULUM II – AREAS OF EXPERIENCE

4.1 Many attempts have been made to categorise the range of knowledge and skills, some access to which, it can be argued, should be the birthright of every human being irrespective of ability, creed, social or economic background, ethnic origin or sex. One approach which has commonly been quoted and used in recent years employed the following list of areas of experience:

aesthetic and creative
ethical
linguistic
mathematical
physical
scientific
social and political
spiritual.

This categorisation of desirable areas of experience is not without its critics but there is a fairly wide agreement that its use as a check list when constructing, reviewing or reshaping a school curriculum does help the teachers involved to develop a more coherent view of the whole curriculum and see more clearly how their contributions complement those of their colleagues.

4.2 Each school should be able to show how its various curriculum areas contribute to development in each of these areas of experience in each year of schooling.
Note that this requirement applies even in the last two years of compulsory schooling when various subject option systems may be operating.

4.3 Examples are given in Appendix B showing how various subject areas chosen by schools for managing their curricula may be analysed in terms of their contributions to these areas of experience. It is important to note that these are only examples and schools should devise their own methods of analysis suited to the range of subject areas they choose to identify. It is not the Authority's intention in this policy statement to specify the subject areas which should be taught at any stage.

***Box 13** A statement from Humberside County Council* **(3.4)**

Liaison

The surprising thing about this issue is how few statements really deal with it. Only one that we can discover (Hertfordshire) deals in any detail with Nursery Education and those which pick up the issue of continuity often content themselves with statements of principle. A few, such as the Northumberland statement (Box 14), stand out for their willingness to tackle the problems:

Curriculum continuity	**9.1** Northumberland County Council is committed to the principles of curriculum continuity, both within a school and between schools. Within each school, continuity in the curriculum, with a special emphasis on progression, can only be achieved through the involvement of every member of staff in curriculum planning.
Liaison	**9.2** The three-tier system of school provision in the County depends on efficient inter-school liaison for its effectiveness. The County Council is appreciative of the participation of teachers in this task, and has supported liaison through the County In-Service programme and the work of the advisory staff. However, the process needs to be a continuing one; changes of staff, particularly in first or middle schools can affect the whole pattern of curriculum agreement that has been established in particular areas of learning.
Purposes of liaison	**9.3** The establishment and continuous review of liaison at all levels and in all areas of the curriculum should ensure subject co-ordination and progression by avoiding overlap, repetition and discontinuities and thus represent to the pupils a continuous educational programme from 5 to 16.
Staff co-operation	**9.4** The continuous education of children in a locality from 5 to 16 is most successfully achieved when schools and individual teachers work closely together to negotiate common curriculum and assessment policies and practices.
The outcomes of liaison	**9.5** Every school should have an intimate knowledge of the school or schools from which it receives or to which it sends pupils. Schools should ensure that the comprehensive and sophisticated curriculum policy which is seen as vital in each district is, in fact, a reality.
Principles of liaison	**9.6** The following objectives are suggested for effective liaison: (i) responsibility for effective liaison across the curriculum lies principally with headteachers; (ii) the schools in each school district, or 'pyramid', should maintain a detailed liaison policy; (iii) the arrangements for, and success of, liaison should be reviewed regularly;

continued on next page

(iv) all first schools in a pyramid, and all middle schools, should work towards establishing common, detailed sets of objectives in each of the main curriculum areas. These objectives might be stated in terms of experiences encountered by all children in the respective school tiers by the age of 9 or 13 years, and should identify the key concepts or areas of content, skills and attitudes involved;

(v) some districts have worked towards a common core curriculum from 5 or 9 to 14. This practice is commended. Schools should use the County curriculum;

(vi) no school has the right to dictate the curriculum of another, and staff have been at pains to avoid this over the years. However, recipient schools have a right to expect some common curriculum policies and objectives in their group of feeder schools, and to be consulted before they are finalised. The establishment of curriculum coherence and continuity depends, above all, on common sense, tolerance and professional determination;

(vii) the selection of pupils' information for transfer from one school to the next school should depend on the usefulness of the information to the recipient school in making the best possible provision for the pupil. In addition to a County record card, results of diagnostic or other standardised tests, details of attainment, assessments of potential, intellectual, physical and emotional strengths and weaknesses, domestic circumstances and friendship groupings may all have a part to play;

(viii) both pupils and parents should be actively involved in procedures at transfer. The heads and staff of recipient schools should be afforded every opportunity to meet parents and children in the new intake before transfer takes place;

(ix) pupils and parents from feeder schools should have the opportunity to visit the next school before transfer;

(x) effective pastoral arrangements should be made for receiving children into school at every stage, including those who move into the catchment area of a school during the year.

Box 14 *Curriculum liaison between schools (Northumberland County Council* **(3.5)**

From the examples given it can be seen that there is an enormous variety in the style and content of the policies produced by both schools and LEAs.

What should we look at when comparing school policies?

1 What is its purpose?
   (a) Reaction to LEA pressure?
   (b) Pressure from headteachers?
   (c) The needs of the staff and the school?
2 What is its content?
   (a) A statement about the philosophy of science espoused by the staff?
   (b) A statement of aims and objectives in primary science education for the school?
   (c) Some discussion of the content, skills, processes and attitudes the staff wish to promote?
   (d) Some indication of how the school intends to monitor progress by children in these areas?
   (e) Some discussion of resource management and forward planning?

Very few schools have developed policies that embrace all these features — but there are many that are working towards it.

A policy produced by the headteacher or the headteacher and the teacher with a post of responsibility for science and given out to the staff is less likely to be effective in the classroom than one in which the whole staff have been involved. Such a policy takes time to develop – the first priority is to ensure that the staff are unanimous in their perceptions of science at primary level and are teaching it. When talking to primary schools about their policies it is necessary to dig deeper than the pieces of paper handed out ... an apocryphal story is told of the headteacher who rang up a neighbouring head and said 'Send me over a copy of your language policy will you – we are expecting the language adviser today and he's sure to ask for it'!

Many primary schools are in the process of formulating their policies, largely as a result of the DES funded courses set up especially to tackle this problem. It takes time and effort for the staff of a primary school to discuss and put on paper their ideas about science and the way it should be taught. The policies produced by The Boutcher Primary School and Cubitt Town Infants School have evolved over three or four years, and the staff are now considering the problems of record-keeping and the assessment of children's progress. Over four years staff have moved on and new members have had to be inducted into what has gone before. Policies in the primary school should be seen as continually in a state of flux, incorporating new developments and evolving as staff change. It will be useful for secondary colleagues concerned with liaison to look at

schemes the primary school may have for the assessment and recording of pupils' progress in learning through science (see the Appendix: *Croydon SSCR Group: Primary – Secondary Interface*). Assessment of the individual child's progress in science is a problem which primary teachers are only just having to face up to (**3.6**). As a class teacher, he or she will be responsible for the child's assessment in all curricular areas and for recording that information, usually on a form produced by the LEA. It is this information, or some part of it, that will be passed over to the secondary school on transfer, depending on the LEA. The attention paid to those records will depend on the policy of the receiving secondary school.

There are two widely differing approaches to the records that children bring with them to the secondary school. The first view holds that the keynote of the transition should be continuity, and to this end secondary teachers set great store on the extent and quality of the records which are sent from the primary school. The second view is diametrically opposed to the first – it believes that the break between primary and secondary is an opportunity for a fresh start which gives the child the chance to turn over a new leaf.

The LEA policies examined (mostly written several years ago) have on the whole not looked at this problem. Current LEA priorities give far more recognition to the problems of liaison than in the past (see **0.3** and **3.7**) and many LEAs have set up working groups of primary and secondary teachers specifically to tackle the problem. The time is ripe for secondary and primary teachers to become involved together in the production of a meaningful assessment of a child's progress in science, especially if we share Jarman's concern (**1.1**) with the prevention of duplication and the promotion of continuity.

SECTION FOUR

How can we build bridges?

There is no doubt that this is not an easy problem to solve. We venture to suggest that, had it been so, the profession would have found a way a long time ago. One of the main difficulties is that few secondary schools intake from only two or three feeder schools. The problem of very large numbers of feeder schools is most pronounced in metropolitan authorities, particularly where the secondary school is, for example, the only girls' school or the only Church of England school. The difficulties involved in solving problems of continuity under these conditions are far greater than those encounterd where there are only a few feeder schools.

However, we give below a collection of ideas and suggestions which have, collectively and individually, been shown to work. Some or many of them will be familiar to readers, but we hope that there are some thought-provoking notions amongst them. Local priorities will dictate which of these or other ideas will be attempted. We very much hope that those responsible for Phase 3 of the SSCR will give high priority to the further development of these and other ideas.

Liaison for children

These sorts of approaches always involve the children, from either or both schools.

- The holding of an Open Day on which children from feeder schools and their parents are invited to spend the day in the secondary school, which may be working normally or be devoid of children for the day.
- The development of the above procedure in which the secondary school makes an effort to exhibit/display the sort of work which the primary schoolchildren might be involved in doing when they arrive. Often they are invited to join in alongside their parents and the secondary children.
- The carrying-out of identical work on the part of a secondary school and its feeder schools for, say, a month. Such work might be in the form of a project or problem to be solved. At the end of this period the sharing of experiences needs to take place. This can be done by means of a science fair, a competition or a challenge or the like.
- Work started in the final term at primary school can be carried over to be finished when children arrive in the secondary school.
- Discussion by first-year secondary pupils about what it was like to come from primary to secondary school, ideally to be held back at the primary schools from which they came. These can be combined with open discussions in the primary school classroom (**4.1**).

Liaison for teachers, departments and schools

Clearly, liaison at this level starts with an appreciation of the curricula and approaches used by the school(s) on the other side of the divide. It is hoped that this Curriculum Guide will provide a suitable start for secondary teachers to begin to appreciate the aims, objectives and methods of the primary school. Given this goodwill, what mechanisms might be tried?

- Secondary teachers will, of course, need to visit their local primary schools. After some familiarisation, though, they might also try some teaching there! Science teachers lacking confidence might begin by concentrating on a science-based topic and move on from there. Only by this depth of immersion, we believe, will they learn to swim in the primary curriculum and discover the joy of the variety of strokes (and pools!) available.
- Similarly, and probably simultaneously for staffing reasons, primary teachers might try some lower secondary teaching. This should be an effective way of discovering the approach and *raison d'être* of secondary science.
- Probably subsequent to the above events, joint meetings of science (and whole) staffs ought to occur in order to explore the problems and decide on methods of solution. These could and have been accompanied by shared Governor's Meetings and joint meetings of headteachers.
- Advisory services and local institutions of higher education might then be prevailed upon to provide in-service training jointly for primary and secondary colleagues in an area.

What might be the outcomes?

1 One outcome is detailed in *Science 5–16: A statement of policy* (**0.4**).

> 33 *The detailed assessment and recording of pupils' progress in their primary schools and the transmission of pupils' records to receiving schools will help to inform teachers in those schools what science has been studied, what concepts met, what knowledge covered and what skills practised. It is highly desirable that primary schools in a given area should institute some simple cooperative procedures over the content of science education, such as commonly agreed core of science topics, to minimise the difficulties which are bound to arise, especially where receiving schools draw from a large number of primary schools.*

2 But to quote this alone would be to give a false impression that we might be supporting the all-too-common model whereby secondary schools attempt to dictate the content of the primary curriculum. This is the opposite of our intention, for it is fundamental to our argument that it is the responsibility of secondary schools to build on what has gone before. However, a cluster of primary schools meeting whenever possible to discuss problems of primary science might become an effective self-help group where expertise was pooled to the benefit of all. And if agreement about a commonality of core science studies were to be reached, so much the better. Indeed, a recent survey of primary schools in an Outer London Borough (**4.2**) indicated that children entering a secondary school had covered about half of the proposed first-year course whilst still at their primary schools.

3 Such a group of primary schools might then be in a position to write, *for the secondary school*, an ideal first-year curriculum which would build most effectively on what has gone before. This approach might be conjoined or followed by the approach already being trialled in Essex, whereby a primary approach is taken to the first year of secondary schooling with classes having the same teacher for the majority of the week and following a non subject-based timetable.

Only when this kind of position is reached, we believe, will genuine and successful continuity and progression have been achieved across the primary—secondary interface.

What can I do now?

If you are in a secondary school department where a policy for better primary—secondary liaison has not yet been developed, what can you do to ease the problem of mixed backgrounds in science from many different feeder schools? Here are a few ideas:

- Have no patience with anybody who says: 'We'll have to assume they know nothing and start from square one.'
- Talk to your first years about their primary science experiences. Show them that you value their views. Ask them about working in groups, working individually, and about what they have already investigated.
- Look at the children's record forms from their primary or middle schools – what skills, processes and content have they brought with them?
- Organise the science groups in the intake year according to which primary schools the children have come from, rather than by assumed ability, sex, surname or any other method. Usually it will be found that most groups consist of

children from one or two primary schools, who will be happy to be with their friends. In schools with a very large number of feeder schools (one of the compilers experienced forty-seven when he was a head of science!) one group will inevitably be somewhat of a 'ragbag' in terms of the science background of the children. Such a set ought of course to be taught by the head of science or another very experienced teacher. Underpinning this approach might be Ausubel's dictum (**4.3**).

Find out what the child knows, then teach to it.

- Construct a junior science curriculum which is heavily process-based, rather than content-based. New courses about to come on to the market at the time of publication of this Curriculum Guide ought to provide a good basis for such an approach (**4.4**, **4.5**). Such a course suffers less from variation in the children's background and is a better preparation and inspiration for later science courses.
- Embark upon a programme to improve liaison with feeder schools as soon as time and other resources allow.

What have other people done?

Several SSCR working groups have looked at aspects of primary–secondary liaison (see **Better Science: A directory of resources**). In some cases the emphasis is on assessment and record keeping, in others on particular areas, for example computing. In still other groups the continuation of the primary approach into the secondary school is explored.

- The Leicestershire 10+ science group has produced a book, entitled *Primary Science: Secondary Science, Links and their Implication* which records the considerable amount of work carried out by a group of primary and secondary teachers and university lecturers. The book falls into three sections. The first gives experiences of liaison, in the form of short accounts, comments, and the report on a questionnaire given to children both at top primary and lower secondary level. The second part works towards guidelines for science in primary schools, identifying areas of agreement between schools on the nature of education through science at this level, then on the dichotomy of approach shown in various science departments – taking a skills approach or a process approach. This was a useful study to provide at this particular time, because several High schools in Leicestershire were changing their intake ages from 11–14 to 10–14.
- The Primary Approaches to Secondary Science (PASS) group, based in Essex, are exploring approaches to science teaching at secondary level that capitalise on the best of primary practice. They are producing five modules on 'Time', 'Litter', 'Tree leaves', 'Soil', and 'Metals'. Each module will contain both teacher and pupil materials.
- An SSCR group in Croydon called the Primary–Secondary Interface (fuller details in the Appendix) are looking at three aspects of the interface:

  1 assessment and records;
  2 continuity of work;
  3 liaison and dialogue;

  and expect to produce a report and a record sheet for use on transfer of pupils to secondary school. The group consists of teachers from one secondary school and three feeder primaries, all of whom are aware of the complications involved if two or more secondary schools are involved. Their research has found that pupils may have covered up to half of the proposed first-year course before transfer, the aims, objectives and experience being virtually identical. This group proposes a much higher level of interschool visiting to examine teaching styles, development of new materials, and the keeping of clear pupil profiles.

Other examples not associated with SSCR groups follow, and are by no means exhaustive. Many LEAs promote problem-solving days, science fairs and science and technology workshops involving both primary and secondary schools.

- The Piggott School, an 11–18 comprehensive near Reading, takes children mainly from five primary schools. As part of their induction programme for new pupils, the science department has run science lessons each summer term, although largely unaware of the children's previous experiences in science. It was suggested that a series of investigations be tackled simultaneously in each school over a period of weeks, to culminate in an exhibition entitled 'Science Fair'.
- Islington Green School is a mixed comprehensive in North London. Teachers from the science department started a programme of staff visits to their feeder primaries. They found children learning by discovery, by problem solving, and by creating fair-testing situations. It was felt that by developing that work in the latter part of the summer term using Islington Green's laboratory facilities, the children would become familiar with the secondary set-up as an extension of their primary school work.

Conclusions

In this Curriculum Guide we have endeavoured to

illustrate the possibility of the process of liaison becoming a reality for you and your feeder primary schools. We do not claim that our guide is in any way definitive or comprehensive – like so many things in education there are as many problems and as many solutions as there are schools. We have tried to promote the realisation of the rewards of liaison, as well as spelling out some of the difficulties. We have looked at the way a primary school may organise science, and ways science may be taught in the primary classroom. Some schools' policy statements or guidelines provide us with an insight into the school's intentions in primary science, as indeed on a broader scale do those of the local authorities.

Lastly, we have taken a look at the many different ways in which it is possible to take those first faltering steps towards liaison, illustrated by some real examples. We hope that you will be heartened and encouraged by what others have attempted, and will start to examine your own department's practice and that of your feeder primaries in order to provide continuity and progression in science 5–16.

APPENDIX

Croydon SSCR Group: Primary–secondary interface

Phase 1: Curriculum links

Aim

To identify common practice and links in curricula to promote continuity between the primary and the secondary school.

Possible solution

Our limited attempt with the pilot group has been successful in developing dialogue between one secondary school and its feeder schools. If more than one secondary school were to be involved then a wider dialogue would be necessary in order to promote continuity of common practice. In the Thomas report (3.7) ILEA has cited an attempt to cluster schools. They suggest clusters of three secondary schools with their feeder primary and infant schools. These clusters would have frequent discussions and inform parents of any developments. They would also promote inter-visiting between schools. A proposal such as this is geographically feasible within Croydon.

Phase 2: Information transfer

Aim

To maintain a data base of work topics and themes covered, documenting skills and processes encountered by the whole class, with a view to developing individual pupil profiles.

Possible solution

Our first attempts have developed a reporting process including a data base and transfer document encompassing the bare elements of the work experienced in the primary school. This gives no information about individual pupils but does provide the secondary head of science with some knowledge of the experiences of the new intake. The present documentation on new pupils in the secondary school is often only consulted by individual teachers for its pastoral content. Such reports are often criticised as not being specific to all subjects.

In our research we have found that pupils may have already covered up to half of the proposed first-year secondary course. This is a direct result of inadequate information about previous work. The problem is further exacerbated by the fact that the aims, objectives and experiences are virtually identical. This evidence is based on a survey of *Look, Learning Through Science, Schools Council 5–13, Insight to Science* and *Nuffield Combined Science*.

Pupils are often content to say little for a number of reasons, the most common being the security gained from getting something right which pleases the teacher, and the late realisation that the work is the same because of lack of recognition of a different method of presentation.

We feel that there is a need for a pupil profile which runs from the infant school through to the final year of secondary school. This profile need not be subject specific but should list a series of process skills arranged in levels, each stage being identified by selected specific criteria. Each stage achieved should be ticked and dated. This information could be transferred to a computer record which would analyse information and allow reports to be created.

Phase 3: Interschool visiting

Aim

To promote continuity by creating opportunities for interschool visits for both teachers and pupils. Possible solutions

Possible solutions

For teachers, carefully prepared short visits which allow them to take an active part in lessons would help to promote the following:

1 a study of teaching styles;
2 development of conformity of method through cooperative designing of new material or adaptation of existing material;
3 a possible change in the highly structured teacher-centred learning day of the secondary school.

For pupils, preliminary visits to the secondary school may provide a degree of familiarity with the environment. Preliminary visits could take the form of a problem-solving day or interschool field study day.

Constraints

In our examination of the problem, there are a number of barriers to progress:

1 the divergence of practice and opinion between:
   (a) secondary science and primary science;
   (b) content and process skills;
   (c) child-centred integration and teacher-centred specialisation;
2 the lack of coordination which results in inadequate records of work done and the concepts and process skills experienced. In the secondary school records are too often related to concept skills alone. In the primary school emphasis is upon skill acquisition, but there is a lack of confidence in the use of science;
3 the limited amount of contact between the two sectors with an associated mythology about what the other is doing;
4 the discontinuity in the education process caused by each side of the interface having limited information about, or contact with, the other.

Conclusion

For continuity and conformity to exist in the science curriculum, there is a need for schools to enter into dialogue with the purpose of developing accurate record-keeping, clear pupil profiles and interschool visits so that all concerned will have a clear aim for continuity in the science curriculum.

Further reading

The nature of primary science

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Hodgson, B. and Scanlon, E. *Approaching Primary Science*, Harper Education Series, 1985

Richards, C. and Holford, D. *The Teaching of Primary Science: Policy and practice*, Falmer Press, 1983

Curriculum materials for schools

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Books about liaison

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Leicestershire Education Authority. *Primary Science: Secondary Science. Links and their Implications*, 1986

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Video material

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0.3 ILEA. *Improving Secondary Schools*, ILEA, London, 1984

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1.1 Jarman, R. *Primary Science, Secondary Science: Issues at the interface*, SSCR, London, 1984

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2.1 Gilbert, C. and Mathews, P. *Look*, Addison-Wesley, 1981

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3.3 Norfolk County Council. *Science 8–12: Guide to the curriculum* (a consultative document)

3.4 Humberside County Council. *Analysis of the Curriculum* (an Education Department document)

3.5 Northumberland County Council. *Curriculum Liaison Between Schools*

3.6 Harlen, W. *Assessment in Schools*, Macmillan Education, 1983

3.7 ILEA. *Improving Primary Schools*, ILEA, London, 1985

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The Secondary Science Curriculum Review (SSCR) was set up in 1981 to stimulate, through working groups of practising teachers, the development of science studies which would help to provide an appropriate science education for *all* young people growing up in a scientific and technological society — whatever their abilities or career intentions. Its concern was not only with the science curriculum — its contents, purposes, teaching methods and resources — but also with the role of science in general education and within the whole school.

The **Better Science: Curriculum Guides** are based on the combined experience of the Review's Central Team and the working groups. Each Guide deals with a different but significant area of concern. Together they aim to assist teachers both in devising a broader and more balanced approach to science studies and in enhancing their professional development. The intention throughout is not necessarily to provide answers but rather to provoke and encourage teachers' thinking about the various topics addressed.

This Guide, **Better Science: Building primary– secondary links,**

- attempts to answer the questions
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  - how do secondary schools build on this?
- is written essentially for secondary teachers but will be of interest to all who care for science in our primary schools.

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